# Overview of Perception and Distributed Sensing Activity

*Under NASA's Transformational Tools and Technologies (TTT) Project*
*Autonomous Systems (AS) Discipline*

Dr. Corey A. Ippolito
Principal Investigator, P&DS
NASA Ames Research Center
corey.a.ippolito@nasa.gov

# Enabling Autonomous AAM Operations

**NASA Aeronautics Research Mission Directorate (ARMD)**

**Transformative Aeronautics Concepts Program (TACP)**

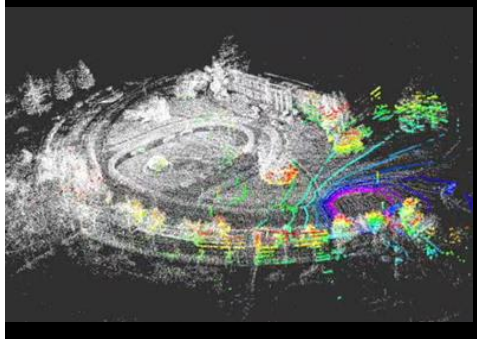
**Transformative Tools and Technology (TTT) Project**

**Autonomous Systems (AS) Discipline**

**Perception Activity**

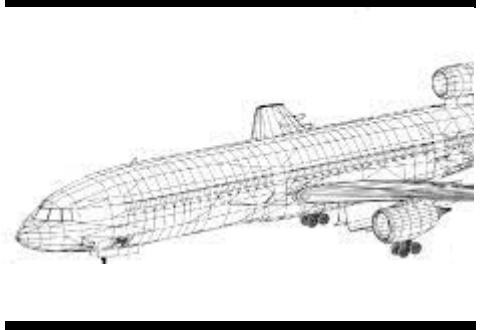
# Perception and Distributed Sensing

**Perception of Environment**



**Perception of State**

**Perception of Health**



**Perception of Airspace**

# Project

| Gaps | Approach | Technical Objectives |
| --- | --- | --- |
| **System-wide Needs and Requirements Gap** | Collaborate with other NASA projects & industry partners to establish needs, requirements, gaps, and challenges for perception in AAM. | **Establish collaborative simulations, scenarios, and requirements with other NASA projects.** |
| **Validated Approaches and Technologies Gap** | Develop approaches, architectures, and algorithms. Perform verification and validation against requirements with the other NASA programs. | **Develop approaches, algorithms, and reference architectures.** |
| **Characterization and Data Gap** | Gather data sets for V&V and characterization. Publish data sets for the community. Analyze data sets and characterize performance of perception systems. | **Data collection and perception system characterization.** |

**Enabling Advanced AAM Operations Through Autonomy**

# NASA AAM Project Partnerships

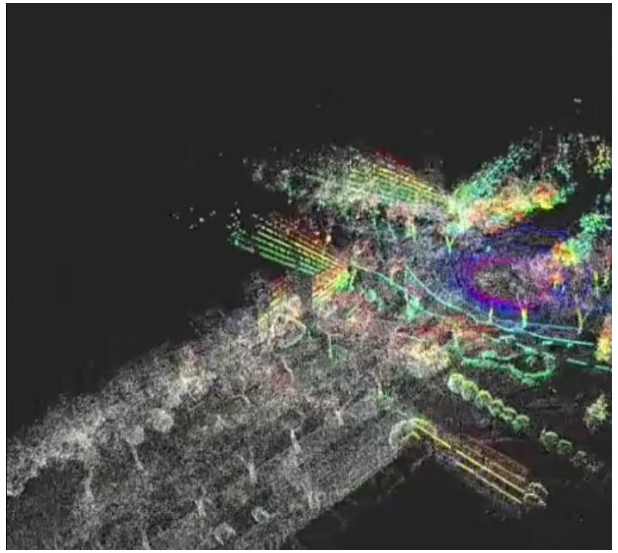
- Transformational Tools and Technologies (TTT)
  - Autonomous Systems (AS) Discipline
    - Perception and Distributed Sensing
    - Intelligent Contingency Management (iCM)
    - Human-Autonomy Teaming (HAT)
    - Autonomous Air Traffic Management (aATM)
- Advanced Air Mobility (AAM) Project
  - National Campaign (NC)
  - High Density Vertiport (HDV)
  - Automated Flight and Contingency Management (AFCM)
- Revolutionary Vertical Lift Technology Project (RVLT)
- Convergent Aeronautics Solutions (CAS) Project
  - Data and Reasoning Fabric (DRF)

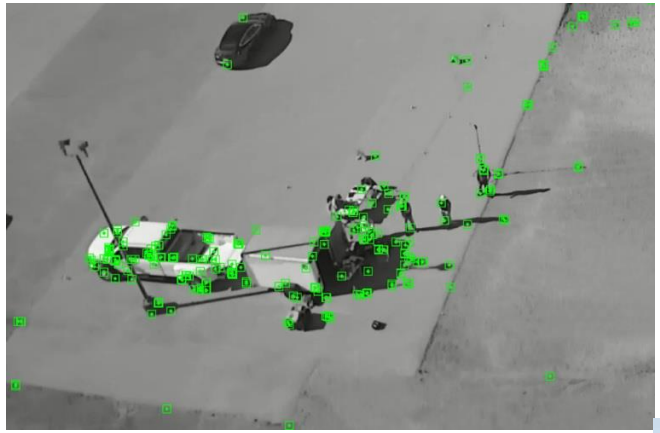
# Technology Focus Areas for Perception in AAM

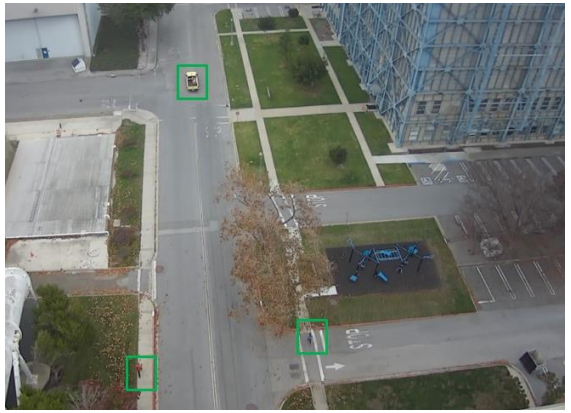
In AAM relevant environments, e.g., low-altitude flight in dense urban corridors…

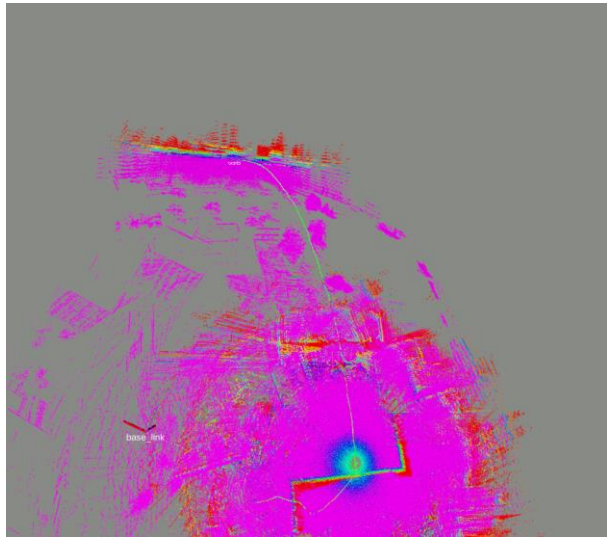
- Technologies for Precision Approach and Landing
- Alternative Positioning, Navigation, and Timing (APNT)
- Detect and Avoid (DAA)
- Sensing and Estimation (Nonlinear Coupled Vehicle/Fluid Dynamic State)
- Weather and Atmospheric Sensing for Weather Tolerant Operations
- Health Monitoring, Prognostics and Diagnostics
- Environmental Hazard Sensing

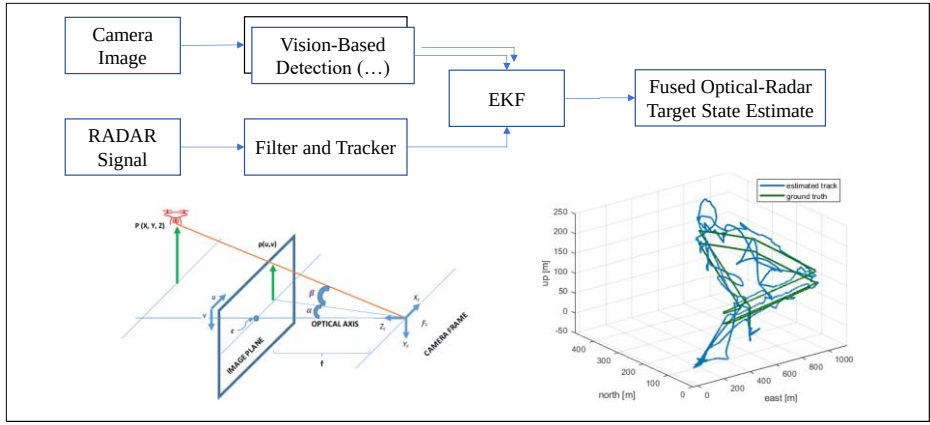
# Ongoing Research









# Collaboration Opportunities

- Concepts, Requirements and Needs
- Technology Focus Areas and Capability Challenges
- Flight Test Data Collection Activities
- Tools and Technologies

# Example Publications from 2022 AIAA SciTech Forum and Exposition (Jan/2022)

- Organized special session “Perception as Enabling Technology for Autonomous Air Mobility”
- Kawamura, E., Kannan, K., Lombaerts, T., & Ippolito, C. A. (2022). *Vision-Based Precision Approach and Landing for Advanced Air Mobility*. AIAA 2022 SciTech Forum and Exposition. San Diego, CA, USA. January 3-7, 2022. https://doi.org/10.2514/6.2022-0497
- Dolph, C., Minwalla, C., Lombaerts, T., Stepanyan, V., Iftekharuddin, K., Szatkowski, G., McSwain, R., & Ippolito, C. A. (2022). *Ground to air testing of a fused optical-radar aircraft detection and tracking system*. AIAA 2022 SciTech Forum and Exposition. San Diego, CA, USA. January 3-7, 2022. https://doi.org/10.2514/6.2022-0498
- Lombaerts, T., Shish, K. H., Keller, G., Stepanyan, V., Cramer, N. B., & Ippolito, C. A. (2022). *Adaptive Multi-Sensor Fusion Based Object Tracking for Autonomous Urban Air Mobility Operations*. AIAA 2022 SciTech Forum and Exposition. San Diego, CA, USA. January 3-7, 2022. https://doi.org/10.2514/6.2022-0362
- Stepanyan, V., Lombaerts, T., Dolph, C., Cramer, N. B., & Ippolito, C. A. (2022). *Estimation With Range Depended Sensor Model*. AIAA 2022 SciTech Forum and Exposition. San Diego, CA, USA. January 3-7, 2022. https://doi.org/10.2514/6.2022-0494
- Behari, N., Holbrook, H. T., Garrett, P., Ippolito, C. A., & Dolph, C. (2022). *Contextual Segmentation of Fire Spotting Regions Through Satellite-Augmented Autonomous Modular Sensor Imagery*. AIAA 2022 SciTech Forum and Exposition. San Diego, CA, USA. January 3-7, 2022. https://doi.org/10.2514/6.2022-0495
- Holbrook, H. T., Garrett, P., Behari, N., Dolph, C., Morris, C. I., & Szatkowski, G. (2022). *Aerial Object Trajectory Classification by Training on Flight Controller Data and Testing on RADAR Generated Tracks*. AIAA 2022 SciTech Forum and Exposition. San Diego, CA, USA. January 3-7, 2022. https://doi.org/10.2514/6.2022-0496

# Perception and Distributed Sensing Research Activity

Dr. Corey A. Ippolito

TTT/AS/Perception Activity, Principal Investigator

NASA Ames Research Center

corey.a.ippolito@nasa.gov